Project Inventory

This is meant to be a working document, that will be added to and modified on a regular basis. The projects represent a wide spectrum of concreteness, difficulty, and importance. I will supply more detailed descriptions of what I have in mind in due course, or on request.

I. MODELS OF EMERGENT EXOTIC STATISTICS

1. Construct Kitaev type 1 models for a richer spectrum of abelian phases (e.g., using tensor product spins) and/or for non-abelian phases. Model of fractional QHE? What is the relationship to conventional gauge theories?

2. Explore more general models of the Kitaev 2 type. "Graphene" with anisotropies and flavor.

3. Generalize Kitaev type 1 to higher dimensions. (W. Waalewijn has done interesting things here.)

4. Thought-engineer designer materials (cold atoms, lithographed "graphene", exotic vortex states ...) alternative to QHE that support exotic statistics.

II. IMPLICATIONS OF ZERO MODES

1. Calculate transport and interference properties in wires and wire networks, using some version of Kitaev's quantum wire. (Chong Yidong has made a start on this.)

2. Thought-design experiments that would reveal the Majorana zero modes directly. (fermion-boson exchange scattering?, NMR?). Calculate these in Kitaev 2 and/or p+ip superconductors.

III. FINDING ZERO-MODES

1. Explore skyrmions, including variants with complicated order parameters.

2. Formulate a sufficiently general index theorem, in a reasonably transparent form, that covers known condensed matter examples and could guide the search for more.

IV. BERRY PHASE

Derive the nonabelian statistics of Pfaffian-type states directly from a Berry phase calculation using wave functions.